Information Theory as a Foundation for Military Operations in the 21st Century

A Monograph
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Abstract

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The United States Army, along with its sister services, is struggling to create effective doctrinal concepts for warfighting in the Information Age. Man's ability to manipulate and transport information at light speed is changing the conduct of military operations. While the services agree that "Information Superiority" is key to decisive operations, there is little consensus as to how to achieve it and what the conduct of "Information Operations (IO)" should entail. The various conceptions for IO can generally be understood as one of two types: *IO as an integrating strategy* or *IO as a capability*. Each of these viewpoints emanates from a distinctly different basic conception, or theory, of the nature of information; and each carries vastly different implications for military doctrine. Carried to its logical conclusion, the IO-as-strategy mindset demands a fundamental reformulation of all warfare. The U.S. Department of Defense must identify and articulate a relevant and theoretically sound definition of information before it can develop practical and effective doctrine for warfighting in the 21st century.

Information has a dual nature that is difficult to grasp, because it exists at the intersection between the mental and physical domains. Prevailing theories of information emphasize either the mental (meaningful) or physical (medium) nature. This monograph recommends that the DoD adapt *Sentient Information Theory*, which fully integrates the physical and meaningful natures of information. Doing so will reduce the confusion surrounding the true role of information in warfighting and subsequently clarify two important issues. First, IO is rightly understood as a strategy for planning the perception of all operations and therefore it cannot endure as a standalone discipline relegated to a single staff section. Second, the increased melding of information technology into the fabric of military organizations and equipment demands clear, meaningful terminology in order to debate, clarify and generally understand which decisions are being made by conscious, moral human beings and which by machines.

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Chapter One - INTRODUCTION

The distinctive characteristic of the Information Age is man's ability to manipulate and move information at light speed. This capability alters the nature of warfighting and compresses the levels of war. Actions on the battlefield can now have immediate impact on public opinion due to the ubiquitous presence of global media. Simultaneously, heavy reliance on battlefield information systems, makes modern armies, and particularly the United States Army, increasingly susceptible to paralysis from attack to their command and control systems. In society at large, information technology is now woven into the fabric of daily life and the Internet has become the central nervous system of the new economy. Our general heavy reliance on technology leads some to fear that the U.S. is now vulnerable to a whole new type of warfare consisting of attacks in the information domain.

Within the defense establishment, this threat is commonly discussed under the rubric of "information warfare."[1] Since the Gulf War all the services have been scrambling to get into the information game by variously creating career tracks, publishing doctrine and establishing organizations dedicated to information warfare. Going further, the Department of Defense (DoD) now maintains that our forces' ability to "collect, process and utilize an unrestricted flow of information" will be "key" to any military success we expect to achieve in the coming era. This concept, known as Information Superiority (IS), is "created and sustained by the joint force through the conduct of Information Operations."[2]

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[1] Information Warfare is a joint doctrinal term defined as "Information Operations conducted during time of crisis or conflict…." However, this monograph invokes the more general term "information warfare" in reference to the conduct of all military operations in the information age. Within this context we understand such specific terms and concepts as Information Superiority, Information Management, Information Operations, Knowledge Management and Information as an Element of Combat Power to represent our initial attempts to develop effective "information warfare" doctrine.

[2] Department of Defense, *Joint Vision 2020* (Washington D.C.:U.S. Government Printing Office, 2001), 3,8.

The Army's new *FM 3-0 Operations* manual dedicates an entire chapter to the concept of IS as an Enabling Operation similar in nature and purpose to Combat Service Support (CSS). Information, now recognized as an Element of Combat Power coequal with Maneuver, Firepower, Leadership and Protection, underlies the Army's ability to "fight and win…in all operations, whether lethal force is used or not." In the Army's new construct, commanders achieve an "operational advantage" through IS by synchronizing three "independent contributors": Intelligence, Surveillance, and Reconnaissance (ISR), Information Management (IM) and Information Operations (IO).[3]

Clearly the concept of "information" is taking on an increasingly important role in both Joint and Army warfighting doctrine. However, in this transitional period, confusion runs rampant as little consensus exists as to precise meaning of various information related terminology. Awash in a sea of jargon, service members struggle to operationalize shaky concepts such as Decision Superiority, Knowledge Management and Information Operations. There is little wonder that this would be the case since we find in the term "information warfare" the union of two of the most elusive concepts known to man. "War" remains such an enigma that neither the Army nor the DoD attempt to define it; and "information", as this monograph demonstrates, possesses a complex nature intrinsically tied to conscious, human experience.

> The role of information in warfare must be to affect strategic or tactical decisions in one's favor. This role is as old as warfare itself; indeed, it might be said to be the very purpose of warfare….one may reasonably wonder how "information warfare" differs from warfare itself.[4]

A clear determination of such a distinction, if one exists at all, is predicated on a solid understanding and articulation of the two concepts involved. The chief occupation of the profession of arms is to continually reveal the nature of war and prepare for future conflict. As a

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[3] U.S. Department of the Army, *FM 3-0 Operations*,(Washington D.C.: Office of the Chief of Staff of the Army, June 2001), 4-3, 11-1, 11-11.

[4] Martin Libicki and Jeremy Shapiro, "The Changing Role of Information in Warfare," in Zalmay Khalilzad, *The Changing Role of Information in Warfare* (Santa Monica, California, 1999), 437.

consequence, information must be defined first. What we eventually determine to be the practical form of IW, will be determined by our definition and underlying theory (understanding) of information itself. The United States Department of Defense must identify and articulate a relevant and theoretically sound definition of information before it can develop practical and effective information warfare doctrine.

Term confusion

Selected DoD and civilian definitions collectively reveal how difficult the term information is to define. The new suite of Army Field Manuals, which are numbered and otherwise specially intended to be more inline with joint doctrine, reference the following definition:

> **information —** 1. Facts, data, or instructions in any medium or form. 2. The meaning that a human assigns to data by means of the known conventions used in their representation.[5]

This definition identifies both of the essential elements of a theoretically sound definition of information: first, information has physical substance; second, it is meaningful to a sentient observer. However, separation of form and meaning into two discrete definitions exposes our deep seated difficulty in comprehending the actual function information serves in our lives. One echelon higher, the DoD definition avoids explicit identification of any meaningful subtext and defines information simply as, "Facts, data, or instructions in any medium or form."[6]

Since the 1996 publication of *FM 100-6 Information Operations*, Army understanding of information has improved. Information was then seen to be, "Data collected from the environment and processed into useable form."[7] This vague conception provided little context for what function, if any, information itself performed and how staffs and units might view their interaction with it. The forthcoming *FM 6-0 Command and Control*, more thoroughly fleshes out

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[5] Department of Defense, *JP 1-02 DOD Dictionary of Military and Associated Terms* (Washington D.C.: U.S. Government Printing Office, 2001) 202; Department of the Army, *FM 3-0 Operations* (Washington D.C.: Office of the Chief of Staff of the Army, 2001).

[6] Department of Defense, *DoD Directive 3600.1 Information Operations (Draft – Rev 6, June 2002),* 1-1.

[7] Department of the Army, *FM 100-6 Information Operations* (Washington D.C.: Office of the Chief of Staff of the Army, 1996), 2-1.

the concept and reveals the Army's increasing need to understand information concepts.[8] However, conflicts in the DRAG text expose the fact that the basic difficulty in articulating the nature of information has not lessened in the last half decade.[9] While initially stating that "information alone has no meaning" the publication inconsistently goes on to define information as "the meaning humans assign to data."[10]

Other definitions for information from outside the DoD provide little better assistance. The *American Heritage Dictionary* defines information primarily as "Knowledge derived from study, experience, or instruction"; yet further as "A collection of facts or data."[11] What then is information, "data" or "knowledge"? Clearly all these terms require concurrent definition. If we are to understand information it will only be within the parameters established by well defined associated terminology.

Why Words Matter

Such insistence on definitional clarity may seem an unnecessary preoccupation; however, it is important to understand the function that words play in our lives. Words are symbols that humans use to communicate ideas. As fundamentally social creatures, man possess an intrinsic need to communicate. Learning and the advancement of human knowledge are predicated on the ability to communicate – without communication, ideas remain isolated mental abstractions.

Whereas ideas are non-discrete, infinite cognitive images, words are isolated, finite mental occurrences that can be represented physically. Collectively, ideas represent our individual understanding of reality. We each exist as entirely independent mental entities connected only by verbal and non-verbal communication via the physical realm. Non-verbal communication does an admirable job of conveying the subtleties of present emotion, feeling and mood. But verbal

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[8] Department of the Army, *FM 6-0 Command and Control (DRAG),* (Fort Leavenworth, KS: Combined Arms Doctrine Division, 2001), dedicates part of a chapter as well as an entire appendix to discussions of information. *FM 3-0 Operations* also dedicates a paragraph to information theory: 11-33.

[9] "DRAG" is the U.S. Army Training and Doctrine Command (TRADOC) acronym denoting status of a doctrinal publication in draft: Draft undergoing A Review (DRAG).

[10] *FM 6-0 (DRAG),* 3-12 and B-1.

and written communication is generally capable of conveying deeper meaning and more complex mental constructs (ideas). Words present our most promising hope for progressing human understanding of reality. We can individually ponder existence but ultimately our ideas prove most powerful and our creativity the most effective when we interact with other human minds.

Words provide a means and framework for shared understanding and create our essential social makeup. Though it is debatable whether an individual actually uses words to think, collectively we deeply depend on language to develop complex concepts and build the shared understanding which forms the basis for all collective action. As such, words matter a great deal. In the context of this study the definition and usage of the specific word "information" is being called into question.

All words exhibit migratory meaning. Their usage varies over time and distance and ultimately words develop new connotations and significance entirely distinct from their original meaning. When a word is recognized in the midst of its migratory progression to be losing all meaning and the word is mentioned solely to evoke a specific context or reaction of recent significance, we say the word has become a buzzword. Such is the case with information.

Meaning is a matter of shared convention, yet "information" is routinely used to relate vastly different connotations, each with remarkably different implications for military operations. This paper argues that there are two broad theories underlying common defense-related usage of the term "information" and that these divergent connotations lie at the heart of the controversy and confusion surrounding information warfare. In summary, the DoD is struggling with information warfare because it lacks a theoretically sound and doctrinally relevant theory and definition for information.

Information as Meaning and Medium

There exists little consensus as to specifically what types of activities Information Operations (IO) should entail; what the implications for training and equipping forces are; and what the

[11] *American Heritage Dictionary*, 4th ed., s.v. "information."

potentialities for IO effectiveness actually are. Each of the service components have differing views as to how to leverage information to their advantage, either as a weaponry capability or as a conceptual guide for planning operations. A survey of the evolution of Army IO doctrine further reveals a clear intra-service discomfort with this elusive concept.[12] In general, the views for handling IO fall into two loose camps: *Information as meaning* (or message) and *Information as medium.* Those who primarily associate with the first theory lean toward handling *IO as an integrating strategy* for all military operations. The logical extent of such a line of thinking could extend so far as to reveal a fundamental reformulation of warfighting – warfare, along with all other forms of human interaction, would be viewed under the general construct of communication. Others prefer the more concrete and seemingly manageable concept of *IO as capability*. Following the IO-as-capability line of logic leads to fielding information weapon systems in units and force packages which are then integrated in a traditional manner into the larger whole of warfighting. This view simply integrates new information age technological capabilities underneath the timeless understanding of combat.

These two perspectives are not necessarily unique to the United States or even Western culture. As illustrated below in Table 1, both Chinese and Russian military theorists have published concepts of information warfare which map directly into these two categories.[13] Though Chinese, Russian and, to some extent, U.S. Air Force thinking has come to grips with these two sides of information, U.S. Army and Joint concepts have not. Both Army and Joint IO doctrine categorize IO as a narrow set of activities executed in either an offensive or a defensive

[12] Richard H. Wright, "The Evolution of Information Operations Doctrine," *Military Review*, (March-April 2000), 30-32.

[13] See Timothy L. Thomas, "China's Electronic Strategies," *Military Review* (May-June 2001), 47-54; "Like Adding Wings to the Tiger: Chinese Information War Theory and Practice," Foreign Military Studies Office; internet, http://call.army.mil/fmso/fmsopubs/issues/chinaiw.htm; accessed 5 November 2001; "Dialectical Versus Empirical Thinking: Ten Key Elements of the Russian Understanding of Information Operations," Foreign Military Studies Office; internet, http://call.army.mil/products/spc_sdy/98-21/diaverem.htm; accessed, 6 August 2001.

	Information as Medium	*Information as Meaning*
Broad Categories	IO = Capability	IO = Strategy
Chinese Views	Electromagnetic arena	Psychological arena
Russian Views	Information-technical	Information-psychological
US Air Force	Information in warfare	Information warfare

Table 1 Dual Views of Information in Warfare

manner. Effectiveness results through synchronization of the various "IO Elements" to support the commander's intent. This approach represents sort of a mediocre amalgamation of the two IO concepts: integration of a limited set of special capabilities. The need to integrate activities under a single strategy is acknowledged; however, responsibility for integration is compartmentalized and relegated to a special staff officer, himself the embodiment of an IO-as-capability mindset.

Human-computer interaction.

A clear understanding of the nature of information has direct implications not only for determining IO doctrine but also for Command and Control and decision support system design. One of humanity's most pressing needs arising out of the information age is the ability to better understand the human relationship with Information Technology (IT). As we spawn increasingly life-like creations, our ability to differentiate between human and machine capacities and actions continually deteriorates. Here again we require clear linguistic tools if we are to discuss, debate and indeed even comprehend the potential decline of human decision making in warfare.[14] If we do not draw a distinction between those actions carried out exclusively in the human mind, as acts of the human will, and those performed elsewhere in nature, by amoral executive agents, we risk losing control of our humanity. As professional soldiers, our responsibility is to safeguard the human element in the conduct of warfare.

[14] See Thomas K. Adams "Future Warfare and the Decline of Human Decisionmaking," *Parameters* (Winter 2001-02).

Monograph Structure

Chapter Two presents the theoretical basis for understanding information. It explains what theory is, articulates the prevailing conceptualizations of information and defines two basic criteria for identifying (defining) information. Chapter Three outlines and recommends a new broad theory of information for the Army to adopt and defines terms closely associated with and necessary to a sound understanding of information. Finally, Chapter Four provides implications for Army doctrine based on the recommended new theory of information.[15]

[15] The majority of thought and research behind this monograph relates to the U.S. Army and therefore the bulk of discussion is limited to the Army doctrine. Nonetheless, as a broad theoretical basis, this theory is applicable to all branches of military service.

Chapter Two - THEORY

The function of theory, doctrine and the like

The word 'theory' is much maligned and oft confused in military circles. Any leader referred to as a "theorist" is most often met with either cautious interest or curious skepticism but never with indifference. The modern, military professional mindset generally thinks of theory as some far-off academic pursuit with little application in the "real" world. Quite to the contrary, theory is actually the most practical and common of tools. Everyone, every single thinking human being, theorizes.

Easier described than defined, theory is what frames each individual's subjective reality. Moment by moment the human mind is bombarded with stimuli, data from our senses floods our consciousness and without some mechanism for filtering, categorizing and otherwise making sense of this cognitive barrage, we would mentally collapse under the sheer weight of input. Theory is the mechanism which unconsciously relates and organizes data input from the physical senses, and otherwise allows our minds to get on with higher order thought.

A mind possesses a vast collection of mental models for how the world works. Throughout life our models are continually collected and refined through learning. Starting with simple models we are able to construct more complex ones with greater and greater explanatory power. These mental models become our theories.

Theory synthesizes, analyzes and explains the past in order to anticipate the future. This refers not only to historical past in the common vernacular sense, but likewise to history in a more general scientific usage. Albert Einstein's theory of relativity is based upon the empirical observation of energy and matter. His theory is powerful because it provides reliable insight into any current observation of matter and energy and provides a reliable forecasting tool for how we expect matter and energy to behave in the future. These same characteristics hold true for any

theory such as an individual's theory of exercise, theory of seasons and climate, theory of calculus or theory of Centers of Gravity. Theory is personal.

An individual possesses multiple sets of theory that combine to form their understanding of reality – reality in general as well as reality at any specific instant in time. As we shall see later, all decisions are based on understanding. Our observation of the present is framed by our cause/effect models of the past which meld together to form our instantaneous understanding. We make present decisions based upon a mental goal of how we desire our life to be in the future - we act with purpose. Our robust "teleological" capacity is a large part of what makes us uniquely human. This powerful capacity highlights the overwhelming importance of having correct theoretical constructs. As humans we make decisions which determine what we do and ultimately change what we become. If my individual theory of gravity is incorrect I may make a quite rational, subjective decision to act in a manner seriously detrimental to my health.

But theory is not entirely personal; obviously a large portion of it is shared and the extent to which theory is shared directly determines the capacity for human interaction. As human beings communicate and come to agree that certain concepts (theories) are essentially "true", a new thing called "knowledge" is formed. The progression of the greater body of human knowledge is in essence the evolution or advancement of shared theory. Shared theory, or knowledge, serves many functions, not the least of which is to form and solidify our social networks. Our individual acceptance or rejection of particular knowledges forms the common ground upon which human organizations stand. A particular set of ideas forms the identity of any social order and the extent to which those ideas are uniformly held and understood by all members defines the cohesiveness and homogeneity of the group. [16]

[16] Peter F. Drucker, *Management Challenges for the 21st Century* (New York: Harper Collins Publishers, 1999), 123; John Arquilla and David Ronfeldt "Information, Power, and Grand Strategy: In Athena's Camp", *In Athena's Camp:Preparing for Conflict in the Information Age (Santa Monica, CA: RAND, 1997),156-157.*

Here we are concerned with the social networks which make up the United States defense establishment, the armed services and most specifically the United States Army. The armed services are somewhat unique in that they employ a powerful tool specifically intended to improve the intellectual homogeneity of the force: doctrine. Doctrine represents the theories, knowledges and procedures officially sanctioned by the services. Most often doctrine is heavy on practical application ("Tactics, Techniques and Procedures (TTP)") and light on theory. This is because doctrine's entire purpose is to empower the force to act in common. Doctrine is the agreed-upon manner of action that is trained into the minds of soldiers – once there, doctrine is useful knowledge, because it drives decision. Doctrine provides the armed forces with a basis for action and such a basis primarily requires nuts-and-bolts, practical instruction. In short, doctrine necessarily provides more "how" than "why."

Nonetheless, before the "how" can be determined, the "why" must be understood. Theory provides the relationship between cause and effect and determines the nature in which the force will act to apply its doctrine. Therefore, a solid theoretical basis must be established before effectual doctrine can be determined or employed. Our capstone doctrine manuals establish the basis from which all other doctrine flows – they are our most theoretical.[17] Nevertheless, they are an incomplete representation of the greater, less homogeneous body of shared and accepted theory present in the mind of the force. At any time there exists a body of ideas which are generally accepted to be "true" and despite, or perhaps because of, our thorough, lengthy vetting process, doctrine is always somewhat out of synch with this body. Indeed doctrine is most effective when it remains slightly ahead of conventional thinking. If it gets too far out front, the masses cannot relate it to their present situation and do not know how to adjust. If it lags too far behind it is ignored as irrelevant.

[17] Such as *FM 1.0 The Army* and *FM 3.0 Operations*

The central intent of this monograph is to highlight the fact that the American military mind possesses an ambiguous and conflicted theory of information. In this we are not alone. No sufficient general theory of information exists and subsequently all sectors of global society continue to wrestle with the effects of the information age. But the U.S. military cannot and need not wait for a comprehensive theory of information. To date we have failed to document a theoretically sound basis for understanding the practical relevance of information on warfighting. As previously shown, our attempts to define information in our doctrine are at best disjointed and vague. Moreover they are not necessarily in keeping with the prevailing views of information present across the force.

Athena's Three Views: Theories of Information

Along these lines there are essentially two dominant theories concerning information. The theories are not mutually exclusive and both are widely held. Depending on the context of the situation, one framework or the other tends to dominate discussion. Indeed the reality that a single person may frequently employ either framework highlights the complex nature of information. While neither of the theories is incorrect, they are both incomplete, leaving room for a dissatisfied cast of abstract thinkers to develop a third body attempting to make up the logical shortfalls. RAND analysts John Arquilla and David Ronfeldt applied the titles Meaning, Medium and Material to these three conceptualizations of information. Using their framework, we now examine information from each of the three perspectives.[18]

Information as Meaning

The classic concept of information places supreme emphasis on its meaningful nature. In a purely semantic context, information is anything that informs – the implication being that it is a human mind which is being made more aware. The rise of information technology has challenged this assumption and demanded deeper explanation for the differences in terms such as

[18] Arquilla and Ronfeldt, 144-145.

data, information and knowledge. In response, during the 1980's, the information systems field originated the notion of a hierarchical relationship among different types or classifications of information. Because quantity is thought to decrease as information increases in quality, the hierarchy is commonly depicted as an Information Pyramid with ascending layers of data, information, knowledge and understanding.[19]

Using this construct, information is essentially thought to be an object, a thing, which changes status depending upon context. A particular blob of information is promoted or demoted from logical level to level by virtue of processing, refining, associating and filtering. Data is the most common and least useful of information. It abounds in quantity, but is of little use without processing. Processing reduces quantity, and by retaining only the most meaningful portions, produces information. Upon further refinement information becomes knowledge and ultimately understanding.[20] Geographer Yi-fu Tuan offers the distinction of increasing complexity to the rising layers of the pyramid: "The difference is one of order of complexity. Information is horizontal, knowledge is structured and hierarchical, wisdom is organismic (sic) and flexible."[21]

The Army officially adopted the information-as-meaning paradigm with the 1996 publication of the Cognitive Hierarchy in *FM 100-6 Information Operations*. The manual does well to clarify the relationships between the layers of the pyramid. Processing, defined as "placing (data) into a situational context," produces information. Through cognition "knowledge is derived from

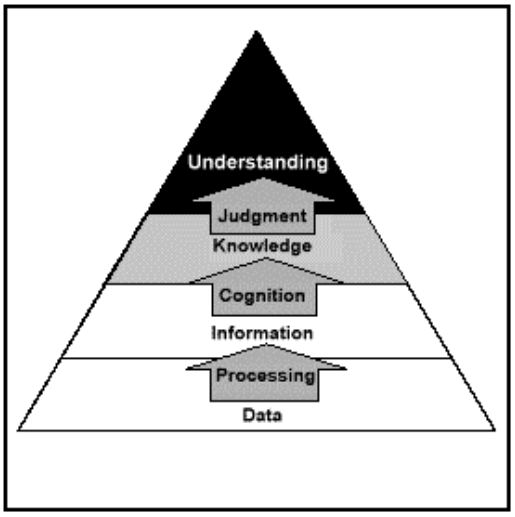

Figure 1 The Cognitive Hierarchy

[19] This conception of information is presented similarly in Arquilla and Ronfeldt, 145-146; Harland Cleveland, *The Knowledge Executive:Leadership in an Information Society (*New York: Truman Talley Books, 1985) 21-23; and Robert W. Lucky, *Silicon Dreams: Information, Man and Machine* (New York: St. Martin's Press, 1989) 19-20.

[20] "Wisdom" is sometimes employed used at the top layer as well.

[21] Cleveland, *The Knowledge Executive*, 23.

information." Cognition is defined as a mental process which assesses and ultimately grants acceptance to information that is found to be factual. Though not explicitly stated as such, from these definitions knowledge is clearly factual information possessed by a human mind. Finally, judgement is applied "to give knowledge relevance within a specific situational context" and the result is understanding. [22]

Attempts to expand and clarify the Cognitive Hierarchy in the latest round of Army manuals have led to some unfortunate wording which has done more damage than good to our doctrinal understanding of information. For the first time a theoretical construct for information was deemed important enough to be included in the Army's capstone doctrinal manual, *FM 3.0 Operations*. Though reduced to a single paragraph, the Hierarchy essentially remains intact from the 1996 version with one regrettable modification. "Analysis and evaluation" have replaced cognition as the transforming means that turns information into knowledge. [23]

Strengths and Weaknesses

The information pyramid has at least three strengths and one key weakness. First and foremost this view of information is important because it is fairly intuitive and widely understood. Information is indeed meaningful and any alternative theory that ignores this subtext does so at the risk of being incomprehensible to a general audience. Secondly, the theory illustrates the distinct intellectual utility between different sets of information; certainly not all information is of the same value. Information "is like fuel for the mind with a kind of energy or octane rating: the greater the visual content the higher the octane level."[24] Finally, the hierarchical nature provides a sound semantic framework, which, if agreed upon, can relate and distinguish between what are otherwise ambiguous and increasingly meaningless words. There is

[22] Department of the Army, *FM 100-6 Information Operations* (Washington D.C.: Office of the Chief of Staff of the Army, 1996) 2-1.

[23] *FM 3.0*, Para 11-33 and 11-34.

[24] James J. Schneider, "Black Lights: Chaos, Complexity, and the Promise of Information Warfare," *Joint Forces Quarterly*, Spring 1997, 27.

no way that we can advance a coherent doctrinal debate concerning the role of information in warfighting until we broadly establish a solid understanding of the terminology.

Despite these strong points this view remains incomplete and especially inadequate within the present context of the information age. Our most pressing need today is for an unambiguous semantic framework that provides a coherent understanding for how humans and machines each uniquely relate and interact with information. What can a human do with information that a machine cannot and vice versa? Our answer to this question delineates the boundaries between doctrine and technology, between organization and information systems and between staff interaction and staff processes. In keeping with general systems theory, the defense establishment's collective belief with regard to this basic issue will drive and determine the outcome of our complex system of force development.[25]

The information pyramid offers no clear distinction between *where* the different types of information may possibly be located. Most people would intuitively agree that the human mind operates at all levels of the pyramid, adeptly handling all forms of information from data to understanding. Moreover, it is fairly obvious that only the conscious human mind is capable of the type of understanding and wisdom represented at the top of the pyramid. But this distinction becomes increasingly less clear with the ongoing advancement in information technology.

Where exactly is the line drawn between human understanding and machine processed data? "Cognition" at one time provided a hint, but now, reflecting the trend in common usage, *FM 3-0* replaces cognition with "analysis." The U.S. Army is a follower, not a leader, in this realm of cheapened information terminology. This decades-old trend was initiated in the business, and specifically marketing, world. In attempt to distinguish products as having more advanced function , "data processing" and "data networks" gave way to "information management" and "information systems." Within the last five years, marketing hype has completely crossed the

[25] Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (Portland, Oregon: Frank Cass Publishers, 1997) 5.

line into the realm of the meaningless with the rise of "knowledge management." This term, more than any other, casts light on our incomplete understanding of the fundamental nature of information. Any discussion of "knowledge management" quickly devolves into the realm of meaningless babble necessitating an immediate pause for terminology clarification. The inflationary terminological trend reveals an intuitive understanding of the hierarchical relationship of the terms data, information and knowledge while simultaneously calling into question the precise difference among the words. What is fundamentally different about data management versus information management? Moreover, what is the difference between information management and knowledge management and what changes do they imply for staff interaction, training and processes?

The pervasiveness of the information-as-meaning paradigm throughout the Army has both positive and negative effects. On the down side, its influence is evident in phrases such as: "We're struggling to understand how we can turn information into knowledge." Such utterances are common in information doctrine and training development circles where emphasis is currently focused on how exactly we might "move up through the Information Pyramid" through distance learning and other computer-based solutions.

On the positive side, the information-as-meaning paradigm leads to a comprehensive (or "full spectrum") conceptualization of IO as an integrating strategy. As we shall see later, this view takes into account the fact the every military action (executed or not) gives off a message, and therefore the function of IO should be to manage the perception of our combined operations. (We return to this subject in Chapter Four.)

Information as Medium

Whereas the previous information-as-meaning model concentrated on the end use of information, the information-as-medium theory focuses attention on the substance - the tangible elements - of information. This view readily acknowledges that information is a component of

communication; specifically, it is the means or pathway which communication utilizes. Those who tend toward this theory are not so concerned with what comes out of a network as they are with the network itself. Information is primarily thought of as something that flows through a pipe or conduit. Common information pipes include all traditional forms of media such as books, television and radio but most commonly we think of telecommunications networks and of course computers. The information-as-medium model focuses on the mechanics of information and as such, "is more about communications than knowledge."[26]

To better understand this direct association of information with its medium, consider a library. A library is a library because it contains vast stores of information in varying levels of complexity (ranking from data to knowledge, according to the last theory). Take the books and periodicals out of the library and you no longer have a library, you now have a building. In removing the media, you remove the information. The books may just as well have been empty or filled with complete gibberish. However, there is no requirement whatsoever for me to know or understand what was in all those books in order to conceive of them as information. I associate "book" with "information" regardless of the content of the book. Moreover, there is no expectation that a librarian has any in-depth understanding of even a minor percentage of the information in a library, yet a librarian is represents a type of information manager. In essence, a librarian manages a physical collection, the infrastructure of information

This understanding of information rose in parallel with the evolution of information technology itself. Prior to the first scribbling of symbols in the dirt there is little likelihood that anyone ever conceived of a thing called information. Indeed there was little purpose in conceptualizing an object without a physical presence to embody it. The creation of physical symbols (written words are simply more advanced physical symbols) gave information its objective existence

[26] Arquilla and Ronfeldt, 147.

Moving into the age of electronic telecommunications, this theory gained considerable momentum through the seminal work of Bell Labs engineer Claude Shannon. Shannon sought to quantify the objective existence of information in order to build more efficient electronic communication systems. As a communications engineer Shannon was primarily concerned with the encoding and efficient transmission of voice communication and therefore sought to remove as much redundancy as possible from speech. Statistical analysis suggests that the English language is relatively redundant. That means that the same amount of information contained in an average message spoken in English could theoretically be communicated using fewer characters.[27] Shannon's greatest legacy in our context though is his usage of the term "information". His body of work sparked the broader field of Information Theory, which represent a foundational body of theory for much of computer and communications technology. In this regard, Shannon's usage of the word information ultimately led us from speaking about the "computer revolution" to the "information revolution." Likewise it is Shannon's usage which sits at the heart of this model's implicit association of information with its medium.

Strengths and Weaknesses

As with our first theory of information, the information-as-medium perspective has strong and weak points. First, the theory presents a fairly comfortable attraction because it offers a tangible entity to which we can relate in the physical world. It is fairly easy to understand what any information task would entail when information is understood to mean an object because the physical world has predictable behavior. In this paradigm, "information management" is readily understood to involve librarian functions – the storage, transportation and maintenance of physical volumes of information. Likewise, "information warfare" immediately brings to mind weapons systems capabilities that involve the physical medium of information: Electronic Warfare, Psychological Operations and Computer Network Attack.

[27] For an in depth analysis of the apparent redundancy in language and the intricacies of encoding verbal and text messages for electronic transmission see Robert Lucky, 37-85.

On the other hand, the information-as-medium paradigm, as with its theoretical parent, Information Theory, cannot handle the difficult, indefinite question of meaning.[28] This model can only quantify the material existence of information, it cannot relate its importance, relevance or impact on human understanding and decision-making. All two pound, eight-by-five inch books are equal; as are all 256-kilobit data streams. In actuality we know that certain bits of information infinitely more important than others, but the information-as-medium model provides no basis from which to understand meaning, context, and relevance.

Information as Material

The final category of information theories is the most radical, uncommon and potentially difficult to grasp. It actually encompasses a broad spectrum of liberal thinking which seeks to integrate physical science and the human perception of reality. Within this category are thinkers who have pondered the existence and nature of information in depth and come to realize that all of the common views are lacking. In general, these narrowly held theories attempt to integrate wide bodies of previously unrelated disciplines by using information as a universal common denominator.

This view generally proposes that information is a prime element in the universe. Information is understood to be "as basic to physical reality as are matter and energy – all material objects are said to embody not only matter and energy, but also 'information.'"[29] In short, information exists. It exists absolutely apart from any sentient mind. Information is not at all a product that some human mind created to describe the relationship between matter and energy, rather it is a sort of "internal" glue that bonds matter and energy together.[30]

In some ways this view is at once the most bizarre and yet plainly obvious. As is frequently the case throughout history, the "forward" thinkers bring us back to something we previously

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[28] See sidebar in John Hogan, "From Complexity to Perplexity," *Scientific American* (June 1995), 109.
[29] Arquilla and Ronfeldt, 148.
[30] Tom Stonier, *Information and the Internal Structure of the Universe: An Exploration into Information Physics* (London: Springer-Verlag, 1990) 1.

knew, but have somehow forgotten. This view highlights the older, and essentially lost, traditional usage of the word information. The *Oxford English Dictionary*'s first definition of information is "to give form to, put into form or shape." This noun finds its root in the Latin verb *informare*, which means, "to give form to, shape, fashion, form an idea of, describe."[31] Through the advancement of written language and the spread of literacy during the Sixteenth Century, "information" transitioned from verb to noun; in the process, subjective thought found its objective existence in the physical form of information.

Against this background, it becomes quite logical to consider information to be that which provides the universe with its physical form. Once again, such a view is in keeping with our lineage of western thought, in that it parallels directly the Greek notion of the Logos. To the fathers of our philosophical mind, "the Logos was 'reason' or 'logic' as an abstract force that brought order and harmony to the universe."[32] David Foster, summed up the information-as-material view well in his 1974 book *The Intelligent Universe* stating, "The total universe, inclusive of all aspects of matter and mind, show a construction virtually indistinguishable from that of an electronic computer, and all its workings are in the nature of intelligent data processing."[33]

Strengths and Weaknesses

This theory holds great promise in that it has potential to make up the gaps in the previous two, widely held theories. It presents a potential means to reconcile the seemingly irreconcilable dual nature of information. Moreover, it begins to reveal some of the realities of the structured relationship between information, matter and energy, which we will examine more thoroughly in the next section. Taken together, the information-as-material view takes a first step toward a

[31] *The Oxford English Dictionary*, 2nd ed., s.v. "information," 944.
[32] R.C. Sproul, General Editor, *New Geneva Study Bible* (Nashville: Thomas Nelson Publishers, 1995) 1658.
[33] David Foster, *The Intelligent Universe* (New York: Putnam, 1975) 39.

unifying "theory of everything" – the grand search to reconcile the violent incompatibilities between theories such as quantum mechanics and classical physics.[34]

Naturally, this theory is not without its weaknesses, not the least of which is that it is not readily apparent. Not that Einstein's theory of relativity is either, but conceiving of information as some sort of cosmic glue has virtually no basis with our common usage of the word information – should time prove the theory out, a new term will likely for the concept to gain momentum and widespread acceptance.

Finally, in order for information to have a truly objective existence, it must be completely separated from meaning.[35] Anything which exists entirely outside the human mind and distinct from any meaning, is by definition unknowable and becomes a matter of faith. Faith issues exist in the realm of theology. Essentially, this model describes some sort of objective relationship between all matter and purpose for the universe. But this is a purpose which, by definition, we cannot know and therefore is of little utility. This points to the third chief weakness which is that information physics completely calls into question (allows for) the reexamination of virtually all human knowledge or, at the very minimum, the physical sciences. Such a complete overhaul is unlikely to provide much in the way of progress. However wrong our existing theories of physical science may be, they have at least provided a great deal of practical utility and have historically proven themselves quite useful.

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[34] See Max Tegmark and John Archibald Wheeler, *Scientific American* (February, 2001) 75, which describes the concept behind such a theory of knowledge: "…quantum mechanics…is probably just a piece in a larger puzzle. Theories can be crudely organized in a family tree where each might, at least in principle, be derived from more fundamental ones above it. Almost at the top of the tree lie general relativity and quantum field theory. Disciplines such as computer science, psychology and medicine appear far down in the lineage. At each level in the hierarchy of theories, new concepts are introduced because they are convenient, capturing the essence of what is going on without recourse to the theories above it. The ultimate goal of physics is to find what is jocularly referred to as a theory of everything, from which all else can be derived. If such a theory exists, it would take the top spot in the family tree…."

[35] Stonier, 18.

Control – The Physical Nature of Information

Though each of the identified views of information provides relevant insight into a single essential aspect of information, they are each incomplete. Information is indeed meaningful. It feeds the human mind and enables decision-making. We cannot depart too far from this understanding without sacrificing semantic context for the word. The information-as-message model recognizes the incredible affect that computer and communication technologies have on our lives. Information may be timeless, but our ability to control it via technology is a recent phenomenon with awesome ramifications we are only beginning to understand. The second view of information validates the reality of the information phenomenon. The final view provides valuable recognition that information does indeed have some sort of fixed relationship with matter and energy. How that relationship plays out with relation to our physical and mental capacities is what we need to establish. Any theoretically sound definition of information will account for all these attributes and aspects.

Cybernetics, Programming and Control

Cybernetics, the formal study of control, provides a powerful model for understanding the nature of information. At its heart, Cybernetics provides a model to explain the inner workings of the goal-directed systems that appear frequently in nature. A system is broken down into two entities: the controlling and controlled agents. The two agents each play a unique role in the attainment of a goal. The controlling agent possesses a program which consists of two essential elements: (1) the goal, which is a vision or understanding of the desired end-state, and (2) procedures for directing the process toward the goal. The controlled agent possess the ability to act on the instructions of the controlling agent and feed back the current status of the process. In this way, a feedback loop is established. The controlling agent feeds forward instructions for actions to be taken and the controlled agent constantly monitors and feeds back the resulting state.

This resulting process moves automatically toward the pre-determined goal possessed by the controlling agent.[36]

The understanding of feedback systems has been a powerful tool in harnessing the energy of the industrial revolution. James Watt harnessed the "volcanic fury of expanding steam and tamed it with information. His flyball governor is undiluted informational control" allowing the physical power of expanding steam to be leveraged at maximum capacity without spiraling out of control.[37] Far more common to our daily existence is the example feedback system most often cited by Cyberneticists: the thermostat. Thermostats act automatically to regulate the temperature in your home at a goal temperature. The thermometer feeds back information regarding the current temperature status in the room. The controlling agent then compares the current state with the desired state (goal temperature) and issues forward instructions (turn on/ turn off) to correct any discrepancy.

Within the context of a control system information finds its meaning and objective existence. Understanding the control process is important because it provides the first glimpse into the relationship between information, matter and energy. The temperature set in the room can be described, recorded and generally handled as information. Though the desired temperature is immaterial, through the power of a feedback mechanism, information wields controlling power over the expenditure of matter and energy. "Information and control represent two sides of the same coin", and through Cybernetic science we are provided a means to understand the interactions between the mental and physical domains.[38]

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[36] Nobert Wiener, *The Human Use of Human Beings: Cybernetics and Society* (New York: Avon Books, 1950).

[37] Kevin Kelly, *Out of Control: The New Biology of Machines, Social Systems and the Economic World* (Cambridge, Massachusetts, 1994) 115.

[38] Schneider, "Black Lights," 22.

Maxwell's Demon

Insight into the relationship between information, matter and energy owes largely to the theoretical challenge posed by Scottish physicist James Clerk Maxwell in the late 19th century. Maxwell outlined a theoretical situation which appeared to overturn the second law of thermodynamics. Maxwell's demon was a creature endowed with the single ability of opening and closing a hole between two sealed chambers in such a fashion as to let heated molecules collect in one chamber and cooled molecules in the other. While the second law dictates that all closed systems, including most notably the universe, proceed consistently toward equilibrium or entropy, Maxwell's demon was unexplainably able to reverse the flow.[39] Without expending any work (other than the movement of the frictionless hinge), the demon was able to increase order in direct violation of the second law.[40]

Control science gives us insight into what Maxwell, and decades of scientists after him, took for granted: the cost of collecting, processing and communicating information. We now understand the demon to be a program which makes predetermined choices based on a set series of inputs[41]. Those inputs are information about the speed and trajectory of the molecules and the status of the hole. Maxwell did not understand that the demon could not collect and process information about the molecules without some expenditure of energy. "Information always requires at least an expenditure of energy sufficient to transmit it" and scientists a have since proven that the energy expended by the demon in collecting (seeing) and processing information would necessarily exceed the heat gradient created by the demon.[42] In other words, the second law holds true because there is an energy cost associated with merely gathering information about

[39] Entropy is this sense is best understood as total randomness or equilibrium, sometime described as the inevitable "heat death" of the universe because the general trend in nature is for all matter and energy to migrate toward uniformity.

[40] For a clear, comprehensible explanation of Maxwell's Demon see Robert Wright, *Three Scientists and Their Gods: Looking for Meaning in an Age of Information* (New York: Times Books, 1988) 92.

[41] Interestingly enough computer programs which run continuously unbeknownst to the operator are commonly known as "demons" in the Unix operating environment.

[42] Heat gradient is the rate of increasing heat differential between the hot and cold chambers.

a piece of matter. Modern understanding of Maxwell's Demon thus established a fixed relationship between information, matter and energy.

> In summary, there are three lessons to be learned from Maxwell's demon:
> (1) control involves programming
> (2) programs require inputs of information
> (3) information does not exist independent of matter and energy, and therefore must incur costs in terms of increased entropy…"[43]

Information processing as the basis for physical life

Understanding that information is in fact physical – that is to say it has a fixed relationship with matter and energy – and that cybernetic feedback loops provide the means by which information can be made to control matter and energy, opens the door to further insight into the nature of physical life itself. As we have already established, the second law of thermodynamics dictates that the entire universe is migrating toward entropy (or stasis). Physical life, on the other hand, exists in direct, if only temporary, contradiction to the second law. Living things are in fact highly complex and organized. They begin as simple cells and increase in order exponentially as they grow into complex organisms. Living things do this by taking in matter and energy, storing them for internal consumption and discarding leftover matter and energy into their environment. Viewed from this perspective the laws of thermodynamics in essence define what living organisms must do to survive or in fact to have their very existence: they must control the ordering of matter and energy.

> Purposive organization and control…define the tangible discontinuity that distinguishes life from the inorganic universe. On one side, the exclusive province of the physical sciences, we find only matter, energy, and their ordering in the epiphenomenon we call information. On the other side, our own side in that we ourselves are living systems, we find structures purposively organized…for information processing, communication, and control, the special subject matter of the behavioral and life sciences.[44]

Any living creature can thus be viewed as an information process. We commonly understand today that our bodies are made up of atoms and molecules. One often hears the fact that our

[43] James R. Beniger, The Control Revolution: Technological and Economic Origins of the Information Society (Cambridge, Massachusetts: Harvard University Press, 1986) 48.

[44] Ibid, 35.

bodies are over 70% water repeated with a sort of curious humor. Still the reality that we don't naturally associate the order of those molecules as an information process reveals our shallow understanding of the concrete role information plays in our lives.

One of the thrilling aspects of having children is gaining additional insight into the wonder of our physical human existence. Most mothers and fathers are fascinated to find out that during gestation the amniotic fluid in mother's womb completely changes out every 24 hours. That is to say that not one of molecules present in the fluid at any moment was part of the fluid a mere 24 hours prior. (This is why mom goes visits the bathroom so often!) But fluid exchange we can accept fairly easily. It is perhaps more incredible to know that in fact every molecule in our bodies changes out on a routine basis.[45] None of the physical matter that made up "me" just a few months ago is still part of me. Since this naturally includes my brain, "where," I am left to ask "am I"? If my physical existence is ephemeral not only in the long term, but the short term as well, what defines and shapes my physical existence? The answer is DNA.

DNA is a program and an information processor all rolled up in one. DNA provides the definition (the goal, program) for what my body physically looks like. Moreover, DNA is an information processor - it is the Maxwellian demon of my physical life. My DNA is what takes in information (feedback) about matter and energy that I consume and issues forward instructions for that material's organization (use) in my life process. DNA is the program that gives my life physical existence.

In summary, DNA is a program (information process) which controls the ordering of matter and energy to enable physical life. Information is the stuff that makes control of the physical world possible and therefore information finds its existence in the physical world. However, thus far we have only examined information within the context of cybernetic feedback system. Within a single system the significance or meaning of information is never brought into question. The

[45] Wiener, 137.

signal sent from controlling to controlled agent is mutually understood by both parties by definition of the system. Outside of the system the signal has no meaning. It turns out that this assignment of meaning to a signal is where true magic occurs. It is to this topic that we turn in the next section.

Purpose – The Meaningful Nature of Information

The elemental model of control provides understanding of the physical nature of information. The concepts of programming and control provide powerful insight into the essential process of all physical life: organizing matter and energy through information collection and processing to stave off heat death. Living systems control matter and energy through the cybernetic feedback process and, as we have seen, it is this material process of control which gives information its objective existence. However, it is also within the confines of a single control process that information finds its second definitional characteristic: meaning. The significance or relevance that a given material signal has to a program is its meaning. An input stimulus which causes an output instruction from the program is by definition meaningful. Instructions fed forward affect physical action by the controlled agent. In this manner, a three-way relationship is established among information, meaning and action. "Meaning turns information into action."[46] The meaningful nature of information shapes, informs and determines physical action.

Within the context of the thermostat example, a positive voltage level, fed forward to a furnace means "turn on" because that is only one of two possible signals (difference in voltage) that the furnace is capable of recognizing. Zero voltage means "turn off." The physical structure as well as the meaning of the information is imbedded and determined by the design of the system. The physical format is an electrical signal of given attributes (current, phase, frequency, etc) and the signal's meaning is determined by specific variation (e.g. voltage level or phase shift, etc). The thermostat loop by its very nature is incapable of interpreting physical signals or stimuli

[46] Wright, 101.

of any other form. It does not recognize material signals of any form other than electromagnetic and even if it could, such signals would have no significance to the program, would cause no output instruction and therefore would be meaningless.

While cybernetics provides a sound model for understanding both the physical and meaningful nature of information, it ultimately is limited in its capacity to explain deeper issues of life. Cybernetics specifically models the process of execution and pays little attention to the far more challenging notion of purpose. How, for example, did Maxwell's demon determine the desired end state of having hot molecules in one chamber and cold in the other? "It is not the thermostat that determines the temperature of the house but the person who sets the thermostat…Feedback devices are only executive mechanisms that operate during the translation of a program."[47]

Human beings display a remarkable teleological capability; their actions, like other living systems, are end-directed.[48] Human activity is goal oriented and taken with specific, predetermined results in mind. How can we account for this purposeful behavior? The end directed behavior of most living systems is embedded in its genetic code. For example, DNA contains the target organization of matter and energy that make up a given life form. However, James Beniger goes further to suggest that conscious entities appear to have an additional, higher-level capacity for further programming and that human beings in fact appear to be the most programmable of all living systems.[49] Starting at birth, the human mind is then understood to be "programmed" with multiple visions of acceptable, attractive or desired state. What is "right" is programmed into us in the form of social norms and values. Family aspirations, civil laws and religious norms build layer upon layer to form a personal vision and expectation of what a desirable future state amounts to.

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[47] Beniger, 66.

[48] James J. Schneider, "The Theory of Operational Art," *Theoretical Paper No. 3* (Fort Leavenworth, Kansas: School of Advanced Military Studies, 1 March 1988), 4.

[49] Beniger, 59-60.

Beniger maintains that we are able to accept this notion of human programming without any "metaphysical implications" including notions of "free will."[50] In other words, there is no reason to believe that individual human minds have any personal role (or responsibility) for their own programming – our minds are merely the compilation of a lifetime of human interaction and experience. But while such a notion may explain the actions of a single human life it meanwhile begs the question: Where did the process begin? After all, cultural values, laws and expectations are by their very nature teleological and future oriented – they look to the future. So while the acceptance and assimilation of a norm may account for the end-directedness of the recipient, it cannot account for the same behavior in the contributor. How did the first benefactor of the norm come to look to the future? Someone made a choice. It seems that our ability to understand the notion of "future" at all is fundamental to conscious human existence, and consciousness in turn tied to the ability to choose.

Information is tied to meaning, meaning to purpose and purpose to consciousness. Forays into the nature of meaning and purpose are necessarily problematic. Fortunately, in the context of warfighting we need not delve quite so deeply into the unknowable realm of the "why" and may restrict ourselves to the real, observed and consistent behavior of man. Soldiers have long acknowledged that men have a will, which drives their actions with purposeful intent.[51] Part of the emotional reality of human experience is a passionate desire to act. Every person experiences this drive on a continuing basis, it is an essential part of our conscious existence and indeed it is the root cause of all war. "Conflict arises from the fundamental teleological nature of man."[52] In other words, all conflict is conflict of the human will.

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[50] Beniger, 49.

[51] Most notable is Clausewitz's identification of the will as a defining element in his famous dictum: "War is thus an act of force to compel our enemy to do our will." Carl von Clausewitz, *On War*, Edited and Translated by Michael Howard and Peter Paret (Princeton, New Jersey: University Press, 1976) 75.

[52] Schneider, "The Theory of Operational Art," 4.

Chapter Three - RECOMMENDATION

The discussion in the previous chapter reveals that a theoretically sound definition of information must account for both its objective, physical nature and its subjective, meaningful nature. To have relevance to the Army the definition must define the boundaries between human minds and computers. Finally, the definition must provide clarity as to the rational, effective formulation of information warfare doctrine. This chapter recommends a new theoretical basis from which the Army can soundly define information and judiciously consider the role of information in warfighting.

Re-invigorating the Cognitive Hierarchy

In attempting to establish a theoretically sound and doctrinally relevant definition for information, it becomes necessary to define closely related words as well. As has already been discussed, the finite and interrelated nature of words mandates that one word be used to define another. We are attempting here to describe a variety of closely related and indeed overlapping ideas; therefore, it is impossible to establish a precise and narrow definition for information all by itself. In order to clarify the body of concepts which the term information represents, we must also establish those ideas which it does not; those related ideas must be handled by other words.

The Cognitive Hierarchy with its association of data, information, knowledge and understanding provides a sufficient semantic framework from which to begin. These terms are in widespread use today even if their exact meaning is increasingly vague through their association with information technology. This section recommends changes to the Cognitive Hierarchy which expand the theory to account for both the physical and meaningful character of information. The resulting model integrates the two prevailing views of information, allows sufficient interpretative room for the third and provides clear insight into the logical structure of information warfare doctrine.

The chief challenge for a theory of information with utility for the military is clarification of the relationship between humans and machines. The rise of technology has long turned humans inward to search for the essence of their life. Writing early in the twentieth century, poet T.S. Eliot exclaimed,

> Where is the Life we have lost in living?
> Where is the wisdom we have lost in knowledge?
> Where is the knowledge we have lost in information?[53]

Eliot's poem provided the initial inspiration and structure for the Information Pyramid which the Army ultimately adopted as its Cognitive Hierarchy. Two authors, Robert Lucky and Harlan Cleveland, each separately derived and published an information hierarchy based almost entirely on Eliot's poem. Both authors credit Eliot and likewise, both modified the structure by adding a base layer of "data."[54]

Eliot, writing more than half century before the widespread use of computers, likely had no idea of the lasting impact of his words. Still his lament is perhaps more appropriate today than it was in his day. He was reflecting on the loss of some of the rich nature of human experience at the hands of increased knowledge and information. Today our loss of perspective as to the value of our human experience remains challenged via the increased capability of our machines to process and organize information in life-like ways. Though Eliot was likely lamenting the deluge of information in the relatively low-tech form of books, newspapers and telephones, his challenge was the same as ours: not losing perspective on life in the face of information technology.

It is clear that the hierarchy set forth by Eliot referred entirely and unquestionably to human beings. By appending data to the bottom of the hierarchy Lucky and Cleveland opened the way for Eliot's terms to be eventually taken over by machines. Data, since the earliest days of computers, had belonged in the numerical, computational realm of machines. The step from data to information was a short one and had indeed already taken place in common usage by the time

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[53] T.S. Eliot, "The Rock," *The Wasteland and Other Poems* (New York: Harcourt, 1955) 81.
[54] Lucky, 19-21;Cleveland, 21-23.

Lucky and Cleveland wrote in the 1980's. Claude Shannon's work in the 1950's successfully disassociated information from meaning and firmly established the processing of information as well within the reasonable bounds of machine technology. The final assault and devaluation of terms is underway now through the marketing hype of Knowledge Management software and systems.

Ascribing the capacity of processing knowledge to machines was never the intent of either Lucky or Cleveland. Both authors allude to a transition from the physical form to the mental, thinking realm. Lucky writes, "When we take in information ourselves, for example by reading, and consciously or not store it in our minds with the rest of our remembered information, we create something personal, and at a higher level yet of organization. Now we call it knowledge."[55] Cleveland says simply that information "isn't knowledge until I have put (it)…to use in my own mind."[56] Peter Drucker highlights the fact knowledge is central to individual identity:

> In the knowledge society into which we are moving, individuals are central. Knowledge is not impersonal, like money. Knowledge does not reside in a book, a databank, a software program; they contain only information. Knowledge is always embodied in a person; carried by a person; applied by a person; taught and passed on by a person; used or misused by a person. The shift to the knowledge society therefore puts the person in the center.[57]

Attending to Drucker's construct, palpably reminds us that people are of increasing value in the information age – one manages knowledge by leading people; not by developing higher-tech information systems.

The Army's adaptation of the Cognitive Hierarchy originally acknowledged the shift from the physical to the mental domains taking place between information and knowledge - the term cognition applied to that which is necessary to transform information into knowledge. However, the Army's model opened the door to confusion by focusing the definition of cognition on the

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[55] Lucky, 21.
[56] Cleveland, 23.
[57] Drucker, *Post-Capitalist Society,* 210.

assessment, testing and acceptance of information as accurate or true, rather than on the classic inference of the term in its association with sentient mental processes. The Army defined the end product of cognition, knowledge, as "information that has been tested and accepted as factual."[58] Therefore, even though human cognition might be required to validate the information as truthful "knowledge", the end product might still exist as physically recorded information. It would have a different name or label; it would be information of a different status, but it could still exist within and be able to be processed by a machine. The latest version of the Cognitive Hierarchy which appears in *FM 3.0* validates the widespread confusion concerning the nature of information when it discards the term cognition altogether and replaces it with "analysis and evaluation."[59]

Therefore, the first step in reinvigorating the Cognitive Hierarchy is to draw a clear distinction between the mental and physical domains. (Figure 2) The physical domain is the objective universe. It is the visible realm of matter and energy where things live and where humans perceive their bodies to have their physical existence. Humans perceive their interaction with one another and with nature in the physical realm through their five senses. Information, computers and other human creations exist in the physical domain. The mental domain is the wholly individual experience of consciousness. It is the invisible realm of the will, the place where humans think, where they possess knowledge and

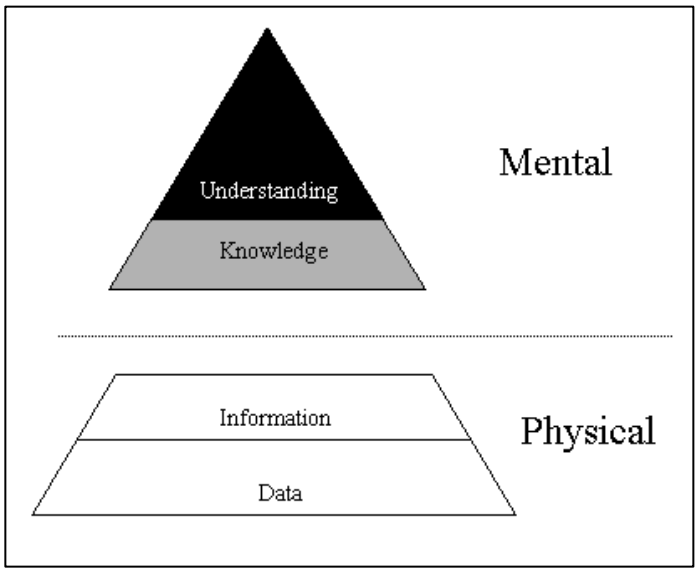

Figure 2 Mental and Physical Distinction

[58] *FM 100-6*, 2-1.
[59] *FM 3.0*, 11-33.

where their subjective view of reality is continually formed. While the mental domain is completely individual, the physical domain is shared.

Descartes – Duality

Drawing a distinction between the mind and body admittedly has extreme limitations. French philosopher Rene Descartes' belief that such a distinction existed has influenced western thinking since the early seventeenth century. Descartes' division of reality into the discrete categories of mind and matter is better known as *dualism.* Dualism's divisionary methods proved immensely useful during the Enlightenment and paved the intellectual way for great scientific advances. In general, science seeks understanding through division; sub-dividing all of reality into discrete packages allows for understanding through in-depth, focused observation. "The term science come from the root word which means to 'break apart' or 'cut', hence the word scythe or schism." Art, on the other hand, means to "put together."[60] It is all about creation and union – making connections where once there were none. While the world has benefited greatly from the technological advances of modern science it has not come without cost. An unwavering belief in the primacy of material existence along with an accompanying fragmented worldview rules the western mind. Not only do we intuitively believe that mind and matter are separate, "materialist science has concluded that matter is prior to mind."[61]

Subsequently, drawing a distinction between mind and body serves two purposes in the present context. First, it "meets us where we are" so to speak. Dissection readily communicates the meaning of individual parts to the modern western mind. Secondly, it highlights the incapacity of a purely scientific method toward explaining the nature of information. Understanding information requires a union of seemingly un-joinable parts. Certainly the time is ripe for new thinking, for though the artistic expression of the Renaissance made way for the

[60] Schneider, "The Theory of Operational Art," 3.
[61] Jennifer Cobb, *Cybergrace: The Search for God in the Digital World* (New York: Crown Publishers, 1998), 8.

scientific rational of the Enlightenment, reciprocal turnabout has yet to emerge after more than three centuries. Though science and technology have given us the information age, surviving the information age will most certainly require creative inspiration. Warfighting, the most human of endeavors, fully embraces both art and science and accordingly, our theoretical bases must be sufficiently robust and broad to counter the multi-dimensional challenges of warfighting into the information age and beyond.

Terms (Data, Information, Knowledge, Understanding, Decision)

Data

By their nature, data and information are the same thing; they differ only in degree, not in kind. Of the two, information is the definitional element and data is a type of information. This is not to say that we have data-information and information-information, we simply have information. Information is the thing, and for information that is especially cluttered, disorganized and of little relevance or utility we reserve the special title data. Information can then be thought to exist across a sort of spectrum of utility. At one end is highly specialized information of the highest value and providing the most precious, pure news to a decision maker. At the other is an ocean of useless sludge which would require a mind's lifetime to sort through to find anything of value: data – all of it meaningful, little of it relevant. The axis or orientation of the spectrum along which information's utility is found is defined by the observation of a sentient, conscious mind. In other words, information's meaning is relative to the observer. Two observers viewing a single body of information gain different utility.

Information finds its physical existence in the form of a signal – a combination of mass and energy that can be differentiated from background noise either by the human senses directly or with the assistance of technology. Light waves, sound waves and odors are all forms of information. Drops of ink on a page, the electromagnetic polarity of a section of computer disk and a line in the sand are likewise forms of information.

Information is that physical element which has relevance and meaning to a metaphysical mind. How much relevance and meaning depends on what information and which mind. A body of data may be transformed into information through organization. The process of organization and its output is structured to have relevance to a predetermined knowledge set. Machines may very well be involved in the collection of data and the organization of information, but determination of what data to collect and how the data will be organized into information is ultimately made by a human.

Information

Information is a physical signal that is meaningful to a knowledge set resident in a human mind. In terms of their nature, there is no difference between data and information; both are physical signals. What differentiates them is their state of organization relative to a specific knowledge set. (Figure 3) This means that data and information have an objective existence whose meaning is determined by the subjective observation of a human mind. It is the knowledge resident in that mind which determines whether the data observed has meaning or utility. Data and information can be thought of as two ends along a spectrum. At one end we have data, observable though largely meaningless and at the other end highly meaningful, relevant information with great utility to the observer.

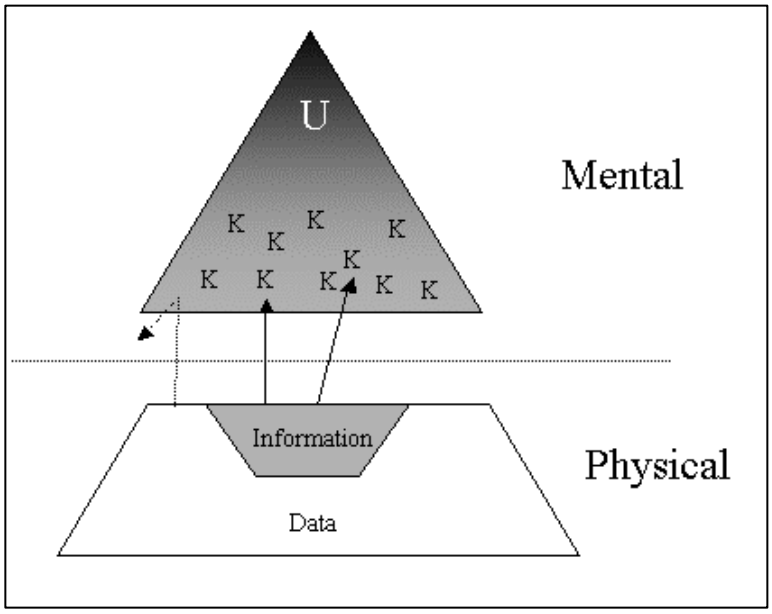

Figure 3 Information's relevance to a Knowledge set

A sentence written in French for example has little meaning to someone who only reads English. On the other hand it does contain some information because the alphabet used has meaning to the observer's English knowledge set. The same sentence has virtually no meaning to someone who reads only Japanese or who can't read at all. Consider also an x-ray image. When viewed by the layman it may appear as meaningless and formless as clouds, but when viewed by the specialist it conveys volumes of critical information.

The father of Cybernetics, Norbert Wiener, put information into its appropriate context of communication when he said, "Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it."[62]

Knowledge

Knowledge is the second (and final) "thing" in our model. Knowledge can be thought of as an object because it can be shared; however, such a conception is metaphorical because knowledge has no physical existence. Knowledge is that which is comprehended or present in the human mind. It is an individual's set of theories about how the world works and what the person has taken to be true. Knowledge is gained through education and experience and it is our shared knowledge sets that define our social networks. Our ability to speak a language, our cultural sensitivity, knowledge of Army doctrine all represent individually possessed knowledge. And to the extent that a knowledge set is shared between two or more people, a social network is formed – or at least made possible. Americans commonly refer to this as "having something in common."

Libraries are often thought to be full of knowledge but they are not, they are full of former and potential knowledge stored in the form of static information. Knowledge must be transcribed as information before someone else can have new knowledge of it. There is virtually no utility in conceptualizing a library as being full of knowledge on the basis that the books cover topics

[62] Wiener, 26.

which are thoroughly advanced or perhaps specially tailored to a particular audience. It would be better that we come up with more descriptive names for various forms of information than to use up the concept of knowledge on something that is not immediately available to effect decision-making. Using the word knowledge to differentiate a calculus book from the newspaper has little utility. On the other hand, using "knowledge" to differentiate what is in a thinking person's head from what is on a computer hard drive has great utility. Knowledge is information which is believed, and belief involves an act of the human will.

Understanding

Knowledge builds, combines and integrates in a mysterious way to form a person's subjective reality: their understanding. Understanding is likely not as good a description for the mental process as might be the term *individual reality*. Understanding carries with it a connotation of accuracy, as if a person's individual perception was measured against truth. This is in fact the case, but then we have no way of judging the accuracy, because any other perception of reality is equally subjective.

Like data and information, knowledge and understanding differ in type but not in kind. Knowledge and understanding are the same thing in that they both exist solely in the human mind. Here too, it is probably better to think of understanding as the essential thing, the total mental collective of the individual. Knowledge is only a discrete subset of the whole of understanding defined by its shared relationships with other human minds.

Understanding is uniquely individual. No two people see the same situation in the same way. Each has a unique understanding, based on their unique knowledge sets gained through a lifetime of unique experiences. Out of a person's unique understanding of the world, new knowledge is formed. Once new knowledge is formed in cannot be perfectly communicated. Knowledge of calculus is known to exist, but where does the one true body of calculus reside? No where. Even the most distinguished math scholars the world over each have a unique understanding of what

calculus is; and should one of them sit down to write it in a book, the book would only represent some fraction of the scholar's understanding. Moreover, the book is meaningless until some other human being takes the time to study it, at which point the student will gain only a partial understanding of the "knowledge" contained in the book. Now twice removed from the source, whatever the student learns will necessarily be decidedly different from what the teacher knows; moreover, the student's new understanding of calculus will be uniquely shaped by his other knowledges.

In one sense this is intuitively obvious: we know that knowledge originates in the human mind. Moreover, if we take the time to think about it we realize that the only place that knowledge can exist as knowledge is in the mental realm. This occasionally is referred to as "abstract knowledge." But such a distinction is unnecessary and indeed seldom verbalized: the counterpart to abstract knowledge would be concrete or tangible knowledge and we know that such a thing does not and indeed cannot exist. Such a thing would be information. Just as information is the meaningful, physical fuel that feeds a knowledge set, knowledge is the theoretical, intangible, infinite substance that finds its imperfect physical distillation in the form of information.

Decision

In review, we see that people are impacted with data which they either disregard as meaningless or use in accordance with its relevance to their knowledge sets. The mind processes information like fuel, continuously combining knowledge sets to form a present awareness or understanding.

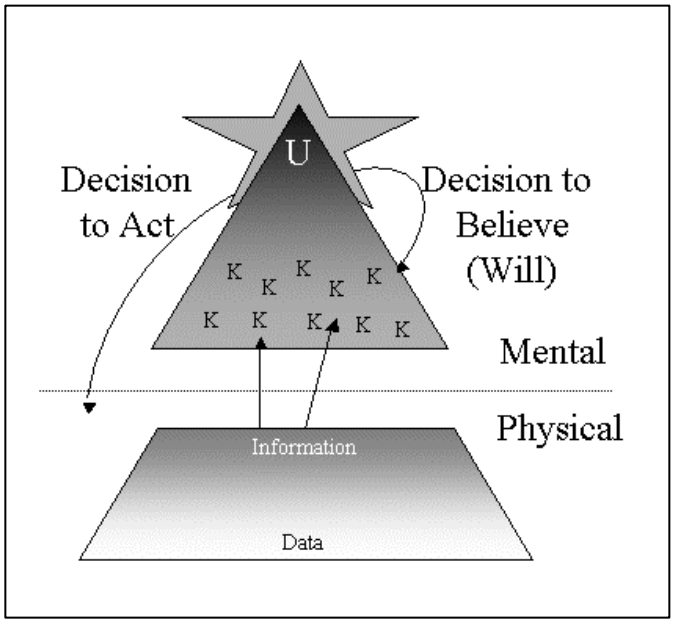

Figure 4 Two Types of Decision

Understanding is a person's subjective view of the world at any given instant and in the context of information theory, represents the equivalent of consciousness. A person's unique sets of knowledge continually combine with information from the environment to form their individual reality and collectively form the basis upon which to make decisions. Based upon their perception of the present situation, humans envision a desired future state and make decisions which will take them toward that state.

There are two types of decisions humans make: decision to act and decision to believe. (See Figure 4). A decision to act is one that has immediate consequence in the physical world. It is a command issued to the body to do some thing like speak or run and it is based on previous decisions to believe. In contrast, a decision to believe involves an act of the will. A decision to believe is an individual choice, an act of judgment, which has immediate impact only in the mental realm. It is a decision to take a certain piece of information to be true and thereby modify an existing knowledge set or create a new knowledge set. A decision to believe impacts the way a person sees the world and therefore influences future decisions.

Sentient Information Theory

At this point the hierarchical nature of our renovated Cognitive Hierarchy model begins to lose utility. The classic information-as-meaning model envisions information as ascending a ladder of utility through varying degrees of organization. But organized according to whose knowledge base? And where does the information reside and how does it support decision making? A new model,

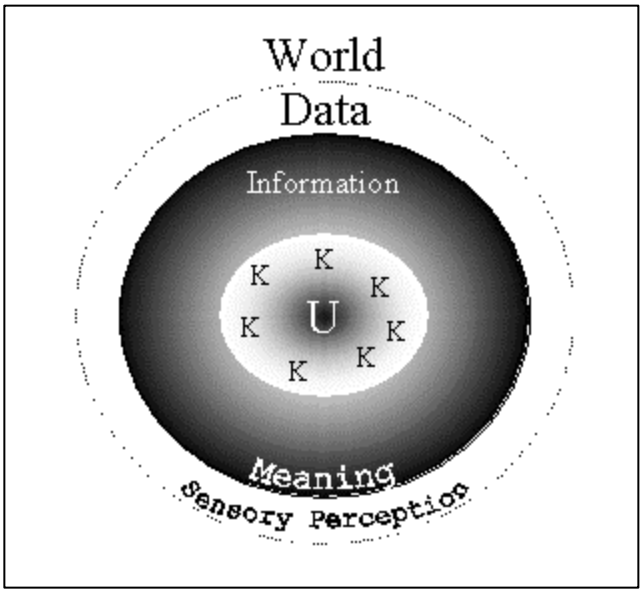

Figure 5 The Sentient Information Model

Sentient Information Theory, immediately focuses emphasis on the conscious individual. (See Figure 5) By placing understanding at the center of a circular model representing individual existence, we gain insight into how information drives human decision. Additionally, this structure provides a construct for understanding the central role that information plays in human social interaction (communication).

The definitions for data, information, knowledge and understanding remain unchanged. What does change is the perspective from which information is viewed. By putting the individual mind at the center of the information model we derive two mirror image perceptions of information. An individual, depending on personal bias will either view the definitional existence of information as being *internal* or *external.* (See Figure 6). The internal (or egocentric) view perceives information as being anything that informs the conscience and assists in decision making. In contrast, the external (or exoteric) view of information is concerned chiefly with the

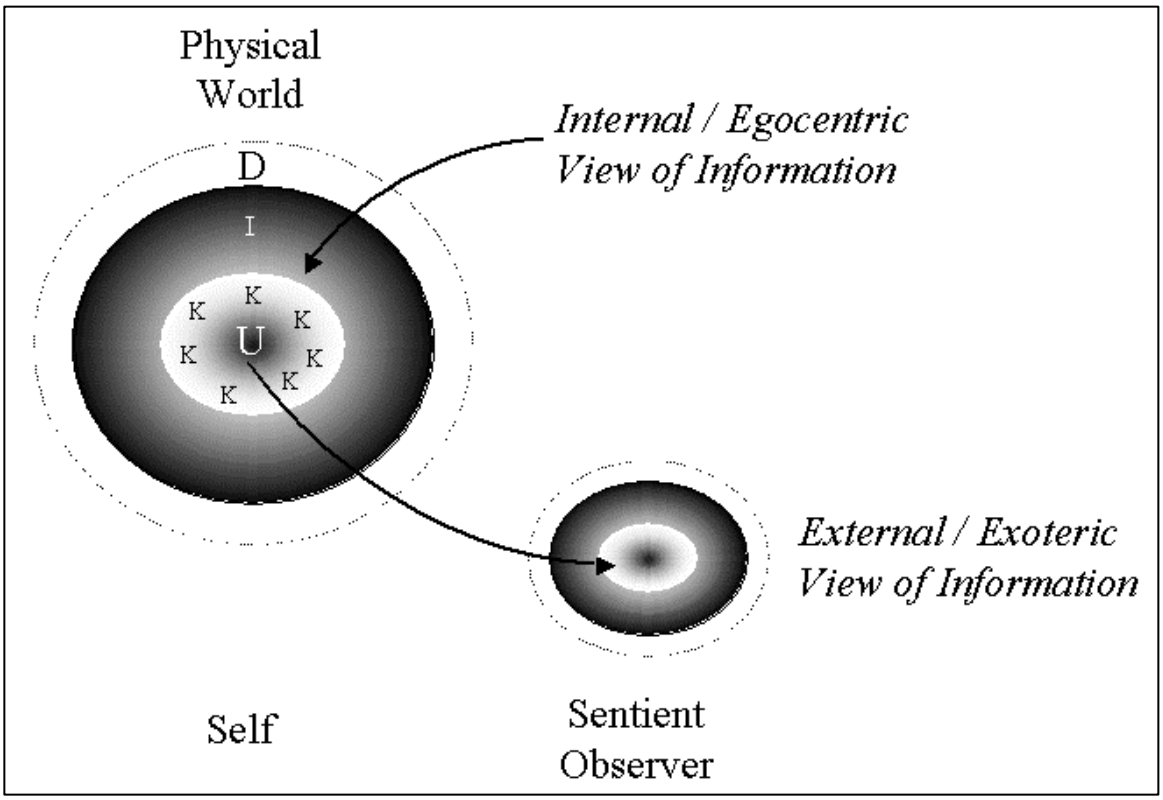

Figure 6 Internal and External Perspectives of Information

external perception of action. The external view recognizes first that any decision to act generates new information, the meaning of which will be determined by other observers. The external view thinks first about how others will perceive the actions which result from my decisions. This does not suggest that either of these views is more correct – they are both correct. Neither of these views presents a full understanding of the natural function of information. Both are required for they differ only in terms of perspective. They are flip sides of a coin representing the two primary viewpoints which are naturally the concern of any organism. This reality is routinely observable in the natural division of roles, responsibilities and orientation manifest in the hierarchical social organisms we call organizations:

Internal	***External***
Mother	Father
President	CEO
Chief of Staff	Commander

In each of these examples the internal perspective is chiefly concerned with the function and operations of the organization; how the internal parts communicate and function efficiently together toward their common objective. In direct contrast, the external perspective provides overall direction for the organization by maintaining focus on the interaction of the organization with the rest of the world. Naturally, these orientations are not absolute; each of these actors maintains some awareness of their contra perspective. However, their persistent reoccurrence in social organizations, the fact that hierarchies seem to function best when individuals are allowed to focus on one perspective or the other, serves to highlight our natural tendency to give mental primacy to one view or the other.

This insight helps explain our persistent struggle with information warfare doctrine. Those weighing into the debate will persistently have their opinion of the correct role of information in warfighting shaped by their primary perspective on the truthful function of information in life. Do they see information primarily as something that comes into the self for personal use, or do

they see information as something that they produce and create through action in the world? Highlighting the two perspectives of information, simply sheds light on the fact that different individuals will perceive information in fundamentally different ways and therefore draw completely different assumptions as to the meaning of the term information and the subsequent role of information in warfighting.

Chapter Four - ANALYSIS AND CONCLUSION

The sound understanding of the nature of information, along with the terminological clarity of Sentient Information Theory, produces insight into two difficult aspects of information warfare doctrine. First, uniting the two disparate views of information provides a complete understanding as to the role of information in warfighting and specifically what Information Operations should rightly entail. Second, a semantic framework which clearly distinguishes that which takes place in the conscious mind provides a means by which the Army may collectively discover and better understand human-computer interaction. This chapter analyzes each of these factors in detail with regard to Army doctrine.

Understanding Information Operations

Strategy or Capability?

The Army, along with the other service branches, has developed the concept of Information Operations (IO) in an attempt to deal with the effects of information in and on warfighting. As the doctrine matures, two broad fields of opinion are emerging concerning what the appropriate role of IO should entail. Not coincidentally, the two schools of thought are recognizable as direct descendants of the two dominant theories of information-as-meaning and information-as-medium. Those who view information primarily from a meaningful perspective believe that the execution of IO must take into account military activities of all types. Therefore, IO should represent an *integrating strategy* which essentially warrants designing operations with effects in the information domain constantly in mind. In contrast, those relating more closely to the physical form, or medium, of information feel that IO should be about new *capabilities.* The integrating strategy concept maintains that absolutely every activity an Army conducts produces information and therefore must be integrated to support a single coordinated plan. Those of dissenting opinion complain that such a concept provides nothing new, for if "everything is IO, than nothing

is IO, its all just warfighting." Consequently, IO becomes a useless concept unless it provides a new capability. Here the IO-as-capability crowd argues that only new weapon systems, such as Computer Network Attack, should be included under IO doctrine; IO capabilities would in turn would be integrated with other combat activities under the traditional understanding of warfighting. Something of an amalgamation of these two schools of thought has been codified in Army doctrine.

By integrating the meaning and medium views of information into a single theory we come to understand that information is a meaningful, physical substance that is viewed from two perspectives: internal and external. Service doctrine cannot disregard either but rather must manage both perspectives. Returning to our discussion of art and science, we see that commanders are the artists of war. Individual weapon systems and the expertise required to employ them represent the science of war. Commanders, and their planning staffs, employ a strategy which seeks to integrate a multitude of specialized weapon systems for maximum complimentary effect. Weapon systems are employed by specially trained and equipped units. The question raised is, whether either the artful command function of planning or the employment of a specialized set of weapon systems should be labeled "Information Operations."

Integrated Planning (the Art of war)

The history of Army IO doctrine reveals a conspicuous trend toward embracing IO as an integrating strategy or integrated planning staff function. The current, 1996, version of *FM 100-6 Information Operations*, discusses the interrelationship of Command and Control Warfare (C2W), Public Affairs and Civil Affairs as the elements of IO.[63] Since C2W alone involves the coordination of OPSEC, Deception, PSYOP, Electronic Warfare and Destruction, IO is understood to involve at least seven different activities. The 2000 draft version of *FM 3.0* included 11 elements of IO and by the time the final manual was published in June 2001, the list

[63] *FM 100-6*, 3-0.

had grown to 12.[64] Apparently, a growing number of activities are being discovered that have significant effects in the information domain. And though not worded as such, there is latitude in the doctrine to allow for virtually any BOS function to fall under the auspices of IO; "Physical Destruction" is one such sufficiently ambiguous term.

Military Deception in particular cannot be understood as an effective means when planned separately from the overall operation – a unit should not develop an operational plan and then expect to turn to a functional expert to add in some deception. The far more effective means is to consider what the enemy commander will have visibility of at every stage of the operation and build the plan specifically with his perceptions in mind.

The broadening trend reveals an increased awareness and tendency toward the external perspective of information – that is, all activities must be planned with others' perceptions in mind. "Others" in this case not only includes the enemy, but also other relevant actors which have bearing on the situation. These might include host nation civilians and the United States or coalition populace.

Current and emerging IO doctrine establishes the use of an IO Working Group (IOWG) to plan operations with intentional effects in the information domain. The problem is that activities planned by the IOWG must then be integrated back into the normal operations process through the targeting and orders processes. This two-step integration process is cumbersome at best and adds additional complexity to a daily battle rhythm that is already a challenge for a field staff to execute. The only difference between the IOWG and the normal targeting/planning process is one of focus. Traditional battle staff operations center on the physical and increasingly the cybernetic domains, while the IOWG focuses primarily on the cybernetic and moral domains. As proficiency and breadth of focus becomes part of the normal staff process, the traditional staff

[64] *FM 3-0,* 11-18; The 12 IO Elements include: Military deception, Counterdeception, Operations Security, Physical Security, Electronic Warfare, Information Assurance, Physical Destruction, Psychological Operations, Counterpropaganda, Counterintelligence, Computer Network Attack, and newly added, Computer Network Defense.

processes should evolve to consistently (and naturally) consider and design operations for simultaneous effects in all domains. The Battle Command Training Program (BCTP) is already training with this intent in mind. Basic warfighting doctrine, to include support branch doctrine, must expand and embrace all domains and the Army should begin training multi-dimensional operations is in the basic tactics blocks at CGSC and at SAMS.

Planning decisive multi-dimensional operations essentially means designing actions in the physical domain with effects in the information domain as a primary consideration. Execution of such operations requires the central coordination of all activities can possibly be viewed by another party. The joint doctrinal definition of Perception Management (PM) captures the spirit of this concept:

> **perception management —** Actions to convey and/or deny selected information and indicators to foreign audiences to influence their emotions, motives, and objective reasoning as well as to intelligence systems and leaders at all levels to influence official estimates, ultimately resulting in foreign behaviors and official actions favorable to the originator's objectives. In various ways, perception management combines truth projection, operations security, cover and deception, and psychological operations.[65]

Though PM is only sporadically employed today and is not truly a central consideration in Army planning the concept shows the promise as an effective way to approach military operations planning in the information age.[66] With only minor adjustments, the joint definition for PM could easily provide a general conceptual framework for operations planning in the 21st century. Such a construct would centrally manage and coordinate the information effects of disparate weapon systems capabilities, each controlling their execution in a decentralized manner. This idea is hardly new; rather it is in keeping with traditional military operations and reflects the classic art and science nature of warfighting. What is new is the primary emphasis on perception as the fundamental planning factor for all operations.

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[65] *JP 1-02*, 322.

[66] Craig S. Jones, "The Perception Management Process," *Military* Review (December – February 1999) 38; see also *JP 1-02*.

Weapon Systems Employment (the Science of war)

The challenge of determining which weapon systems to build, how to train soldiers and organize them into effective units is as old as warfare itself. Changes in technology continually provide potential for new weapons systems. Likewise, new ways to utilize systems (Tactics) leads to the destruction or major renovation of existing force packages. Sentient Information Theory tells us that absolutely every weapon system has potential effects in the information domain. Every single thing an Army does, from deployment to Public Affairs activities, from logistics to envelopment, creates information and the reception of that information by an observer creates a perception. In every case, it is the manner in which the systems are employed which determines their information effects. A tank, a forklift, a surgeon, a megaphone or a computer are all potential information weapons. Decisions to acquire new systems should be predicated on potential warfighting effectiveness across all domains. Decisions as to required operators, tactics and unit design should be determined through the existing DTLOMP process. Capability force packages should be defined by the determination for unique hardware systems operated by specially trained soldiers and employed as units according to effective tactics. All units have effects in the information domain and therefore we will not benefit from designating "information" units. "IO" is not a capability.

Though all weapon systems may potentially produce information effects, some weapon systems, such as PSYOP and Public Affairs, have effects only in the information domain; perhaps we should organize these capabilities as an information combat arm. Undoubtedly the legalities of such an arrangement would generate much debate; however, any First Amendment controversy would miss the primary shortcoming which is the army-wide mentality toward information domain effects. Labeling any one unit as the "Information Operations" unit gives all other units the intellectual freedom to ignore an especially difficult, yet critical dimension of their operational planning. We are better served to give weapon systems names more descriptive of

their function in the physical world and reserve the term information for more general connotations indicative of the true nature of information.

"C4ISR Integration"

One potential mission area for IO deserving special note is the emerging field of "C4ISR Integration." This unfortunate term nominally refers to the ongoing, ad hoc staff coordination to synchronize the multitude of activities required to employ tactical information systems.[67] Typical tasks include the following:

- Systems and Communications architecture planning
- Coordination for Joint and National level data feeds
- System maintenance and coordination with support contractors
- Coordination with TRADOC System Managers and acquisition Program Managers
- Tracking workstation/ hardware maintenance and upgrade
- Tracking software baselines and upgrades
- Database and workflow management
- Scheduling/coordinating operator training
- Property accountability

This list of tasks tracks so closely to the pervasive information-as-medium understanding that it presents a natural fit for what an "Information Officer" might be thought to do. Consequently, a number of Army FA30 officers find themselves in this very role in the field today.[68] These officers, however, are filling an ugly and widening gap created by the simultaneous introduction of numerous, BOS oriented, un-integrated command and control systems. Each of the Army Battle Command System (ABCS) components is supposedly sponsored by a specific Battlefield Functional Area (BFA). For example, the Maneuver Control System (MCS) is sponsored by the maneuver BFA which includes both the Infantry and Armor branches. This means that the MCS is supposed to be operated by MOS's from the Infantry and Armor branches.

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[67] "C4ISR" stands for Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance. This vague term is loosely used today to refer to a host of subjects only marginally related by their association with information. In general, we have taken a tool from the budgeting world and somehow attempted to "operationalize" it.

[68] FA 30 is the OPMS XXI Information Operations Functional Area – presently officers at I Corps and V Corps are routinely performing these tasks.

Such an arrangement serves to highlight our widespread, immature understanding of the nature of information systems. Information technology is unique in that it is a base or foundational means which can play a part together with virtually any other technology. Said another way, information technology is unique because it "gets into" and changes everything else. As a stand alone word processor, IT presents a fairly discrete and understandable set of functions toward which we might train a soldier. But we have now embedded IT in tanks, aircraft, medical, logistics systems – virtually everything on the battlefield will soon be "digitized." This presents a difficulty in differentiating basic military occupational skills from information processing skills. Previously a tank driver promoted to sufficient grade, could bring his tactical expertise with only a few weeks of training, directly to bear as a battle staff NCO. This is not the case with the highly complex ABCS. These systems require months of training and numerous repetitions of field exercises to gain adequate proficiency. Moreover, numerous issues concerning maintenance, interoperability and mission-specific configuration requirements remain to be ironed out.

The point is that we are in only the crawling stages of understanding how information technology affects our doctrine and MOS structures. Perhaps we should consider ABCS components as weapon systems in and of themselves. We have continued to pigeonhole everything related to information technology under the "C4ISR" rubric and find unjustified comfort in the belief that some "computer guy" has got the management of all the associated systems well in hand. Once we fully come to grips with the myriad tasks and responsibilities involved with the various forms of information technology we will likely determined that a variety of new skill sets are required. We may need entire enlisted and officer structures dedicated to the operation and maintenance of ABCS systems. Perhaps these individuals will be dedicated staff professionals their entire careers. At this point it is difficult to determine exactly what the requirements will be, but we can rightly raise the question as to whether or not we should label this function as "Information Operations." Here again we are better suited to use a

term more narrowly descriptive of the actual physical functions taking place – information is much too broad a term. Realizing that these functions directly support the commander's ability to control his forces and make decisions, perhaps we should go back to where we started and designate a special command and control systems branch, or decision support branch. Whatever conclusion we come to, though, we should not label this function "IO."

IO ultimately must go (Information as a condition)

We have seen that the information domain transcends all physical activity; therefore, our use of the word information must be representative of this fact or we risk losing all effective use of the term. Here we have examined the utility of having "IO" represent either a capstone planning strategy or a weapon system capability. The increased speed at which information moves and the ubiquitous presence of the media mandates that all planning and operations be conducted with effects in the information domain as a primary concern. Weapon systems with effects solely in the mental realm must eschew the "information" moniker lest we intellectually pigeonhole responsibility for this domain to a supporting function and thereby place insufficient emphasis on the information domain in all other areas. We desperately need PSYOP, PAO, CNA and other as yet unrealized capabilities; but we will not benefit, and in fact will do ourselves great harm, by calling them "information weapon systems."

IO must then be an integrating strategy and as such it must itself be integrated into the time proven structure of warfare. Combat arms commanders and planners must broaden their perspective and wholly embrace the concept of planning for effects simultaneously in the physical and information domains. Perhaps the best way to think of information is as an *environmental condition* analogous to light or temperature. It is a bygone conclusion that all armor units know how to conduct mounted operations at night. Likewise, we do not look to the

"Cold Operations" officer to plan and direct the execution of all combined arms operations taking place below freezing temperature.[69]

What of the FA 30?

Under OPMS XXI the Army created the new Functional Area 30, Information Operations Officer. After the preceding discussion, one might conclude that the Army made a mistake and has no use for such a specialty – this is not the case. The FA30 will play a crucial short-term role for the Army during its transitional period from a single to a multi-domain oriented force. By creating a focused specialty, the Army has set aside and dedicated a cadre of officers for the express purpose of thinking about warfighting from this important perspective. FA30's must become experts on the nature of information and how it relates to warfighting and how warfighting fits into the larger context of social interaction and communication. In doing so the FA30 will recommend new weapon systems and develop operational doctrine which achieves maximum decisive effect by simultaneously leveraging the effects of multiple domains. To assist in this development the Army should educate FA30's as broadly as possible and select them for advanced education in such schools as the School of Advanced Military Studies (SAMS).

Once consideration of the information domain has become as natural a part of the planning process as night and cold weather operations, the FA30 should either be discontinued or transitioned to a new role.[70] The nature of the new role will naturally be determined by numerous factors as yet unknown; however, one possibility presents itself already. The FA30 could become a special staff advisor analogous to the JAG and POLAD. Each of these officers can be thought of as specialists in a specific domain; the JAG in the legal domain and the POLAD, the political domain. As such, each of these officers examines the mission from their

[69] The author is indebted to fellow SAMS classmate, MAJ Lou Rago for the idea of treating information as analogous to an environmental condition.

[70] Whether this will take 5 or 25 years remains to be seen.

unique perspective and advises the commander on risks, potentials and ramifications in their area of expertise.

Humans and computers

Sentient Information Theory provides clarification on a second major area with impact on Army warfighting doctrine for the 21st century: human-computer interaction. As originally stated, this is one of humanities most pressing needs arising out of the rise of information technology. In creating computers, man has developed a machine with remarkably life-like capabilities. The cybernetic control model provides insight into why computers are so powerful. Computer systems in a sense possess a limited version of the same teleological capacity as man – in cybernetic terms, they are "programmable." A computer's great power comes in its ability to compare current state to desired, future state, recognize a difference and issue forward appropriate instructions to bring reality inline with the goal. Just as with the thermostat and the flywheel governor, a computer appropriately configured with sensors and actuators possesses the means by which to control the physical world.

Potential decline of human decision

Computer systems assist humans in two ways: First, they provide the information required to make decisions, and secondly, they carry forward execution instructions resulting from decision. In the simplest case the execution instructions merely operate mechanical devices such as traffic lights or cruise missiles. But the process becomes exponentially more complex when the execution instruction involves the processing or creation of new information. A computer has been empowered to do something quite remarkable when given an instruction such as:

> IF A, B and C pieces of data are present
> AND the following conditions exist
> THEN discard B and C, pass forward A

Here computers are at their most powerful and potentially dangerous state.[71] By delegating the decision to organize, filter, delete, create or otherwise process information, human beings give up some portion of the decision making process. If we did not give something up, then computers would not be any help at all.

We can understand this reality better by recognizing the fact that the whole of human activity results from decision-making – all physical action, however slight involves a decision. Large complex activity involves multiple supporting decisions and requires the social organization of human beings. From this perspective, we understand an organization to be, at its very core, an information processor. A staff hierarchy is compartmentalized according to meaningful categories of information. A given bureau is defined by its jurisdiction over a discrete set of information. Each bureau collects, organizes and processes information in order to provide the information that those higher in the chain require to make decisions. Though the entire hierarchy is ultimately dedicated to supporting the decision maker at the top, each sub hierarchy does so by making myriad decisions itself. This subordinate decision support process nests all the way down to the individual worker – the point at which computer systems were originally introduced.

The delegation of masses of simple, rote and largely trivial decisions to computers greatly increases the productivity of a single worker. The result naturally is that fewer, low skilled workers are required for the organization to achieve the same level of productivity. A secondary result is that the first decision now made by a human in the hierarchy now takes place at a higher echelon and therefore takes on increasing importance.

Computer networking exponentially increases the ability of computer systems to share automatically information without human interaction. Again, this increases the computer's decision making potential and raises the possibility of removing more people from the process.

[71] This capability is "dangerous" because of the subjective nature of meaning. By allowing computers to delete data, we potentially discard important, meaningful information – the true value of which is determined by a human observer.

Today, a complete information systems hierarchy exists in parallel to a given human staff hierarchy. In general, the trend has been to delegate to computer systems as many tasks as possible, thus freeing humans to handle only the most complex decisions. This explains why "the information era features a sudden increase in humanity's power to think…."[72] Computers enable us to leverage man's greatest intellectual capacities, but they do so at the expense of freeing our minds from the seemingly mundane stuff of life. We can quickly extrapolate to envision a battlefield where a massive networked computer system feeds a single decision maker. While this scenario may seem far fetched it is important to realize that such a change will come upon us slowly, incrementally and indeed is already happening.[73] In America, the military partners with the civilian world to develop weapon systems and in academia today, the "big revolution is in automating the decision process." In areas such as transportation the primary aim has become "getting the human out of the decision-making loop."[74] It is not a large conceptual leap to realize that such technologies may provide attractive capabilities and advantages on the future high-speed, highly computerized battlefield.

Two mutually supporting trends in information technology work to obscure our understanding of human-computer interactions: Internetworking and artificial intelligence. Internetworking refers to the interconnection of computer networks. The global Internet got its name from this word. Internetworking allows the creation of extremely powerful systems-of-systems of which the Internet is the most common and extreme example. Though internetworking greatly increases processing power, it also exponentially increases the number of possibilities for error. The number of combinations of variables interacting becomes so immense that humans lose all capacity for actually understanding the interactions of their own creations.

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[72] Cleveland, 20.

[73] See Thomas K. Adams, "Future Warfare and the Decline of Human Decisionmaking", *Parameters* (Winter 2001-02); and John A. Keegan, "Computers can't replace judgement" *Forbes* (Dec 2, 1996) 11.

[74] Lee Bruno, "Transportation: Building the real Information Superhighway," *Red Herring* (February 2002) 66.

Just such complex interaction between numerous interconnected command and control systems was one root cause of the accidental fratricide of two Black Hawk helicopters over Iraq in 1994.[75]

Since we now have the technological capability to delegate virtually any decision to computer systems, we are challenged to determine what decisions are morally acceptable to be made by machines. Because warfighting is at its very core a human endeavor there is natural agreement that we cannot ethically hand the decision to take human life over to a machine. However, such moral distinctions will be irrelevant if we are unable to know for sure which decisions are being made by computers and which are being made by humans. The basic foundation for such understanding lies in terminological clarity.

Terminological Clarity

During the last two decades we have experienced a great devaluation in information-related terminology. While the word knowledge once quite clearly held a connotation of human cognition, it is now routinely used as a rank associated with static data residing in a machine. We refer to one pile of worthless bits as "data" and another precious pile as "knowledge." While such a distinction for categories of information may have great utility, the use of the word knowledge (as well as others including cognition) in reference to what a non-sentient machine processes has none. Actually, the usage has a devastating theoretical effect because we are incrementally losing all use of the word. Knowledge will ultimately come to mean what information means today and we will need a new word to represent the mental models possessed within a human mind (knowledge). We need only look back at David Foster's book, *The Intelligent Universe: A Cybernetic Philosophy*, to see that such a transition has already taken place with respect to the words data and information. This 1974 book, which wrestles with the human-computer relationship, described data as that "which sits between the mind and matter duality…." Foster concluded that "data must be able to interface with mind, and it must also be

[75] Scott A. Snook, *Friendly Fire* (Princeton, New Jersey: Princeton University Press, 2000).

able to interface with matter."[76] Sentient Information Theory makes the case that the word "information" today should occupy the same theoretical position as Foster's "data." As our opening definitions revealed, data has now become virtually synonymous with information. We should draw the line now, lest we lose term information as well.

The new *FM 6-0 Command and Control (DRAG)*, maintains the confusing data-as-knowledge theme throughout, going so far as to state that "Knowledge can often be represented on the COP."[77] Further, knowledge is portrayed as the thing that staffs produce for their commander's consumption because the commander is the only one who has understanding. While it is true that the commander's understanding is of paramount importance, we have completely missed the point which Sentient Information Theory brings to the fore: decision making is based on understanding, understanding is summation of personal knowledge as fed with current meaningful stimulus from the environment (information). Everyone on the staff makes decisions and it is only by making a great many decisions that the staff is able to assist the commander in making the few critical ones.

Three Effects

This failure to comprehend clearly and articulate how knowledge, information and understanding work together to affect human decision making has numerous critical consequences. First, we threaten to miss the mark in designing our supporting IT infrastructure. C2 systems must support decision makers at all levels of the staff. The commander has Critical Information Requirements (CCIR) but so does every other staff section (indeed every officer). We must design our information systems to support decision makers at all levels so that they in turn can support the commander. Business philosopher and acknowledged management expert Peter Drucker provides an effective model for understanding organizational information support

[76] Foster, 59.

[77] *FM 6-0 (DRAG)*, B-2; "COP" refers to the Common Operational Picture – a single computer display showing the real-time location and status of friendly and enemy forces in the battlespace.

roles. Drucker tells us that every staff must continually ask the following questions to determine their information requirements and responsibilities:

1. What information do I owe to the people with whom I work and on whom I depend? In what form? And in what time frame?
2. What information do I need myself? From whom? In what form? And in what time frame?[78]

This perspective acknowledges that multiple decision makers in the organization have critical information requirements and the job of the IT support systems should be to get the right information to everyone who makes decisions, not just the commander.

Second, the trend toward computer-assisted decision aids threatens to weaken the self-adaptive nature of tactical fighting forces. A field army is effectively a Complex Adaptive System.[79] Readily observable throughout nature, such systems display a remarkable capability for self-organization. Because of knowledge embedded in the minds of soldiers throughout the force, sub-units are capable of driving on with their assigned mission long after being cut off from the next higher in their chain of command. If we believe we can enable our soldiers to make better decisions in the field through the use of "Knowledge Management" technology, it will only come at the expense of self-organizing capacity. Once computer systems fail, a given fire team will fall farther and faster in their capacity to reorganize and independently carry out mission-type orders. The more heavily reliant an Army is on computerized decision systems, the more vulnerable it is to disintegration through Cybershock.[80]

Finally, the "Quality of Firsts" motto for the Objective Force signals how far our emphasis has shifted away from decision making as the essential human activity. The overall theme driving Objective Force development is the capability to "See First, Understand First and Act First." While decision making may be implied, it is no longer thought to be sufficiently important

[78] Drucker, *Management Challenges for the 21st Century*, 124.
[79] Schneider, "Black Lights," 26.
[80] Schneider, "Cybershock," 56.

to merit explicit identification as was the case previously with the OODA loop[81]. Once again, our semantic shift betrays our subtle mental expectations. Because computers are in fact increasingly involved in the decision making process today, it is a short step for us to place them fully in that capacity tomorrow even despite our own best efforts. If force developers fully embrace the quality of firsts we may indeed field a high tech force which sees, understands and acts with lightening speed, even though human decision making may not be a large part of the process. Perhaps we should be explicit with the single function a battlefield commander alone is empowered with: decision.

Conclusion

Clausewitz warned us that, "War is more than a true chameleon that slightly adapts its characteristics to the given case."[82] Indeed, warfighting continues to transform as we move further into the Information Age. But while the speed at which information moves and man's ability to effect control through information technology, both have had dramatic effect on the conduct of warfare, the central nature of warfighting remains the same. War is a conflict of the human will which has as its defining characteristic a willingness to imperil human life. Life or death sits at the core of warfare.

As we seek to adapt our fighting doctrine to the current environment we should heed C.S. Lewis when he explains that "change is not progress unless the core remains unchanged."[83] Warriors, Combat Arms officers, those who risk and take life, must command the Army and take central responsibility for the art of war in any era. To be effective in the information age, warriors must plan and execute multi-dimensional military operations. Planning for effects in the information domain will necessarily be second nature in modern warfighting; it must be part and parcel of the implementation of all weapon systems.

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[81] Observe, Orient, Decide, Act

[82] Clausewitz, 89.

[83] C.S. Lewis, "Dogma and the Universe," *The Collected Works of C.S. Lewis* (New York: Inspirational Press, 1996) 326.

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